

MANAGING ORGANIZATIONAL CHANGE FOR SUSTAINABLE INDUSTRIAL TRANSFORMATION

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ABSTRACT: *This paper examines the role of organizational change management in supporting sustainable industrial transformation in the context of digitalization, Industry 4.0 and Industry 5.0. The analysis is based on the premise that technological adoption alone is not sufficient to generate sustainable organizational change. Effective transformation requires the alignment of technology with strategy, organizational processes, employee competencies, governance mechanisms and sustainability objectives. Based on the literature on organizational change, digital transformation and sustainable manufacturing, the paper proposes an integrated managerial framework structured around six components: diagnosis of the need for change and organizational readiness, strategic alignment, leadership mobilization and employee participation, the development of competencies, experimentation and scaling, and institutionalization combined with continuous learning. The analysis suggests that sustainable industrial transformation should be understood as a continuous process of coordinated reconfiguration of technologies, processes, competencies and management mechanisms. In this context, change management provides the link between strategic objectives and operational implementation, while organizational learning and adaptability become essential conditions for maintaining transformation over time.*

Keywords: *Change Management; Industrial Transformation; Sustainability; Industry 4.0; Industry 5.0; Digital Transformation; Leadership; Organizational Capabilities.*

JEL Classification: *M10, M14, O32, Q01, Q56*

1. INTRODUCTION

The industrial sector is currently undergoing a profound transformation that poses major managerial challenges. The acceleration of technological change, the development of artificial intelligence, the expansion of automation, the increasing use of the Internet of Things (IoT), together with growing pressures for decarbonization and more efficient resource use, are reshaping the ways in which organizations create and sustain economic value. At the same time, economic volatility, supply chain disruptions, and changes in consumer preferences require organizations to strengthen their adaptive capacity. Under these conditions, organizational transformation should be understood as a process through which the organizational system is reconfigured in order to operate effectively in an environment characterized by uncertainty, interdependence, and multiple pressures on performance.

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In this context, the concept of industrial transformation extends beyond technological modernization in the narrow sense. The acquisition of advanced equipment, the automation of processes or the introduction of digital solutions may generate specific improvements, but they do not, by themselves, guarantee sustainable transformation. Technology must be integrated into an organizational system that includes structures, responsibilities, competencies, decision-making processes, and a corresponding organizational culture.

The introduction of new technologies can reshape information flows, decision-making and organizational systems and the competencies required within the firm. In the absence of appropriate organizational adaptation, the benefits of technological change remain limited. Consequently, the success of industrial transformation cannot be assessed solely through the presence or adoption of new technologies, but rather through the coherent changes they generate within the management system and through the organizational outcomes achieved.

The literature on digital transformation supports this perspective, describing it as a process that involves strategic adaptation, managerial change, and the reconfiguration of the way in which value is created (Vial, 2019; Verhoef et al., 2021). This approach is further developed within the Industry 5.0 concept. The European Commission report by Breque et al. (2021) identifies sustainability, human-centricity, and resilience as three central pillars of industrial development.

Industry 5.0 does not reject digitalization; rather, it broadens the criteria used to assess its contribution to industrial performance. Instead of associating performance primarily with technical efficiency and productivity, this perspective also evaluates technology in terms of its contribution to prosperity, employee well-being, environmental protection, and the industrial resilience.

Sustainable industrial transformation therefore requires the simultaneous pursuit of several objectives: maintaining economic competitiveness, reducing environmental impact, developing human capital, and strengthening resilience. These objectives may be complementary, but they can also generate tensions. An investment with a longer payback period may be justified by lower environmental impact and reduced resource consumption; the automation of production processes may improve efficiency, while creating a need for employee reskilling; and a monitoring solution that enhances process control may be perceived by employees as a form of surveillance. Under these conditions, change management provides mechanisms through which such tensions can be identified, analyzed and resolved.

The literature on organizational change offers several concepts that are particularly relevant in this respect. Armenakis et al. (1993) examine readiness for change in terms of organizational members' beliefs, attitudes, and intentions regarding both the need for change and the organization's ability to implement it. Holt et al. (2007) show that readiness for change is a multidimensional construct that includes change appropriateness, management support, perceived efficacy and personal valence. At the collective level, Weiner (2009) argues that organizational readiness reflects both shared commitments to change and confidence in the collective ability to implement it. These perspectives are especially relevant to industrial transformation, where successful change requires the simultaneous cooperation of multiple organizational functions and professional groups.

The challenge for organizations becomes even more complex because sustainable transformation does not have a clearly defined endpoint. Digitalization, environmental standards, technologies, and work models continue to evolve. For this reason, change management models originally developed for projects with clearly defined starting and ending points need to be reconsidered. Lewin's (1947) contribution remains relevant to the extent that change involves altering the balance between the forces that maintain existing behaviors and those that support a new direction. Similarly, Kotter's (1995) model remains useful with its emphasis on a sense of urgency, coalition for change, vision, communication, and consolidation

of change, but its application to industrial transformation must be combined with continuous learning and adaptation.

2. ORGANIZATIONAL CHANGE MANAGEMENT IN THE CONTEXT OF SUSTAINABLE INDUSTRIAL TRANSFORMATION

Change management occupies an important place in organizational management; however, contemporary industrial transformations require a reconsideration of the way in which it is applied. In the current economic environment, stability is increasingly temporary: technologies evolve rapidly, sustainability requirements are becoming more stringent, and external disruptions can alter operating conditions within a relatively short period of time. Consequently, change management should support not only the implementation of specific change initiatives, but also the development of an organizational capacity for repeated and continuous change.

In sustainable transformation, creating a shared understanding of change serves a dual purpose. On the one hand, it explains the economic necessity of a project; on the other hand, it connects the transformation process with social and environmental objectives. This connection is essential because sustainability may remain a peripheral concern if it is treated separately from organizational performance. Satyro et al. (2022) show that, in the implementation of Industry 4.0, competitiveness and quality tend to receive greater attention than sustainability, while the social dimension is often insufficiently addressed. Under these conditions, sustainability-related objectives should be explicitly incorporated into the purpose of technological projects and into the criteria used to evaluate their performance.

Organizational readiness for change represents an important condition for the success of organizational transformation. Armenakis et al. (1993) distinguish readiness for change from resistance to change and emphasize the role of change agents in shaping the attitudes of organizational members. Industrial transformation involves at least four levels of readiness. The first is technological and concerns infrastructure, interoperability, security, and data quality. The second is organizational and refers to managerial processes and structures. The third is human and includes competencies, motivation, and learning capacity. The fourth is strategic and concerns the alignment between project objectives, sustainability goals, and the organization's overall vision.

The human dimension becomes central within the Industry 5.0 framework. Breque et al. (2021) argue that human-centric industry should place employee well-being at the core of the production process and use technology to support, rather than merely replace, human capabilities. In practice, this means that automation should be designed with consideration for both productivity and quality of work. Automating repetitive or hazardous tasks can improve safety; however, if new roles are poorly defined or place excessive cognitive demands on employees, the social outcomes may be unfavorable. Human orientation should therefore be translated into concrete criteria related to job design, employee autonomy, and professional development.

Organizational culture represents another important component of industrial transformation. Digitalization often requires greater transparency, data-driven decision-making, interdisciplinary collaboration, and a willingness to experiment. These characteristics may conflict with a rigid organizational culture in which information is closely controlled and errors are penalized. In such an environment, employees may avoid experimentation or selectively report information, which limits the organization's ability to fully exploit the potential of new technologies. Consequently, organizational culture cannot be changed merely through the formulation of aspirational values. It also requires adjustments to the mechanisms that shape employee behavior, including reward systems, promotion criteria, mechanisms for

handling errors, employee competencies development and the distribution of decision-making responsibilities.

The development of employee competencies is another essential component, particularly because Industry 4.0 technologies are changing the structure of skills required within industrial organizations. Production employees may need stronger capabilities in data interpretation and the use of digital interfaces, technicians may require new competencies related to sensors and diagnostics, while managers increasingly need the ability to use large volumes of data in decision-making. At the same time, sustainability requires an understanding of resource consumption, environmental impacts, circular economy principles, and the life-cycle implications of products. Under these conditions, organizations should integrate digital, technical, and sustainability-related competencies rather than treating them as separate areas of development.

Dynamic capabilities provide a theoretical framework for explaining how firms adapt, integrate, and reconfigure resources and competencies in environments characterized by rapid technological change and uncertainty. Initially developed by Teece et al. (1997), the theory extends the Resource-Based View (Barney, 1991). While the RBV emphasizes the importance of possessing valuable, rare, and difficult-to-imitate resources, Dynamic Capabilities Theory highlights the firm's ability to transform, reconfigure, and renew those resources in order to create value. Applied to industrial transformation, this perspective suggests that value does not derive simply from the use of a particular technology, but from the organization's capacity to identify opportunities, mobilize resources, and reconfigure processes. The same technology may generate substantial value in an organization that is capable of learning and adapting, while producing limited benefits in a rigid organization.

The literature on Industry 4.0 further confirms the need for an integrated perspective. Sony and Naik (2020) identify critical factors such as strategy, leadership, organizational culture, competencies, and infrastructure, highlighting the complexity of implementation. Kamble et al. (2018) propose a framework for sustainable Industry 4.0, while Ghobakhloo (2020) emphasizes the sustainability functions associated with digitalization and the interdependencies among them. Stock and Seliger (2016) discuss the opportunities created by Industry 4.0 for sustainable manufacturing. At the organizational level, Braccini and Margherita (2019), through the analysis of a manufacturing company, identify potential effects across the three dimensions of sustainability. Ching et al. (2022) further show that Industry 4.0 applications for sustainable manufacturing are interdependent and can support functions that go beyond isolated efficiency improvements. Taken together, these contributions support the view that sustainable transformation results from the coherent integration of technology, processes, and management.

From a management perspective, organizational change should not be treated as a set of auxiliary activities associated with the introduction of new technologies. Rather, it represents the mechanism through which technology is translated into behaviors, routines, and organizational outcomes. Sustainable industrial transformation therefore requires the simultaneous design and alignment of both the technical and organizational systems.

3. INTEGRATED MANAGEMENT FRAMEWORK TO ACHIEVE SUSTAINABLE INDUSTRIAL TRANSFORMATION

Sustainable industrial transformation can be managed through an integrated framework that connects organizational change with digitalization and sustainability. The integrated managerial framework for sustainable industrial transformation should not be understood as a rigid sequence of steps, but rather as a continuous management cycle. An organization may return to the diagnostic stage after a pilot project, adjust its strategy in light of the results obtained, or resume skills development as technologies evolves. This approach simultaneously

integrates the technological, economic, human, and environmental dimensions of transformation.

The first component in an organizational transformation process is to rigorously identify the need for change and assess the organization's readiness to undertake it. From a strategic management perspective, the adoption of new technologies should not be regarded as an objective in itself, but as a means of addressing specific operational, economic, or organizational problems. Such problems may include high energy costs, equipment downtime, quality variability, material losses, increasing traceability requirements, skill shortages, or vulnerabilities within supply chains.

A precise problem definition is an essential condition for selecting solutions capable of generating both economic and organizational value. In the absence of a clear connection between the identified need and the proposed technological solution, there is a risk that investments may be directed toward technologies that are poorly integrated into organizational processes or that have only a limited impact on performance. At the same time, the organization must assess its capacity to manage and sustain the change process. The evaluation of organizational readiness should include technical, managerial, and human dimensions. These dimensions include digital infrastructure maturity, data quality and availability, system interoperability, professional and digital competencies, resource availability, organizational culture, cross-functional collaboration, and senior management involvement.

Such an assessment should not be interpreted as a selection mechanism intended to exclude less mature organizations from transformation processes. Rather, it should be viewed as a managerial diagnostic tool used to identify gaps between existing capabilities and those required for successful change implementation. The results of this assessment can support the definition of preliminary interventions and the development of a realistic sequence of investments.

In some cases, the analysis may indicate that the immediate introduction of advanced technologies, such as artificial intelligence, does not represent the most appropriate priority. Data standardization, the strengthening of information governance mechanisms, the clarification of responsibilities, system integration, or the development of internal competencies may constitute essential preliminary steps. From this perspective, the assessment of organizational readiness becomes an important tool for supporting investment decisions. It helps organizations prioritize resources, reduce implementation risks, and increase the likelihood that the transformation process will generate sustainable outcomes.

The second component is strategic alignment. The transformation process should be closely linked to the organization's competitiveness and sustainability objectives. This alignment is particularly important because digitalization and sustainability projects are often managed separately. The IT department may focus on modernizing digital infrastructure, the production department may seek to improve Overall Equipment Effectiveness (OEE), while the sustainability function may prioritize emissions reduction. An integrated framework makes it possible to identify projects in which these objectives can reinforce one another and provides a common basis for coordination. Strategic alignment therefore requires a cross-functional approach, as transformation projects should not be owned exclusively by a single organizational function.

The third component is leadership mobilization and employee participation. Change must be translated into a credible message that explains why the organization is transforming, what objectives it seeks to achieve, and which principles will guide the process. This message must be supported by consistent managerial behavior. If management states that a project is intended to promote learning but penalizes every unfavorable outcome of an initiative, the organization is likely to become more reluctant to experiment. Likewise, if management claims that employees are at the center of the transformation while designing the system without consulting its users, the credibility of the message is undermined.

The fourth component is the development of competencies and organizational capabilities. Sustainable transformation requires an anticipatory analysis of organizational roles. The organization should identify the activities that are likely to disappear, those that will be modified, and the new activities that may emerge. On this basis, it can determine which competencies should be developed internally, which should be acquired through recruitment, and where external partnerships are necessary. This approach is preferable to a delayed response in which the company realizes, only after implementation, that it lacks a sufficient number of users able to interpret data or maintain the system.

The fifth component is experimentation, learning, and scaling. Industrial transformation involves both technological and organizational uncertainty, and pilot projects can help reduce this uncertainty. However, a pilot project should be designed to test relevant assumptions. Demonstrating that a technology works under ideal conditions is not sufficient; its integration with existing systems must also be tested. Only in this way can the organization realistically assess the costs and requirements associated with scaling.

The sixth component is institutionalization and continuous learning. Change becomes sustainable when new practices are embedded in routine management processes. This requires the updating of procedures, job descriptions, performance evaluation systems, budgets, and performance indicators. If a new digital system is used, only as long as the project team actively promotes it, the change has not been fully institutionalized. By contrast, when the data generated by the system are incorporated into performance meetings, influence managerial decisions, and are linked to clearly defined responsibilities, the technology becomes part of the organization's regular operating routines.

Table 1. Integrated management framework for sustainable industrial transformation

Component	Managerial question	Main mechanisms	Outcomes
1. Diagnosis and readiness assessment	Why is the change needed, and how prepared is the organization?	Benchmarking, readiness assessment, technological and organizational analysis	Clear problem definition and identification of key priorities.
2. Strategic alignment	How does the project contribute to competitiveness and sustainability??	Economic-financial analysis (business case), investment portfolio, organizational governance.	Coherence between strategy, investments and environmental, social and governance (ESG) objectives.
3. Mobilization	Who needs to be involved and how to build employee commitment?	Leadership, communication, participation, change agents.	Acceptance and distributed responsibility.
4. Competencies	What competencies and organizational capabilities are required?	Retraining advanced training, interdisciplinary teams, partnerships.	Enhanced internal implementation and learning capacity.
5. Experimentation, learning, and scaling	What works and how do we scale the solution?	Pilot projects, feedback, lessons learned, selective standardization.	Risk reduction and controlled scaling.

Component	Managerial question	Main mechanisms	Outcomes
6. Institutionalization and continuous learning	How can the changes introduced by the project become sustainable organizational practices?	Integrated Key Performance Indicators (KPIs), responsibilities, budgets, periodic review	Sustainable change and continuous adaptation.

Source: Author's elaboration based on the reviewed literature

A cross-cutting element of the proposed model is the performance measurement system associated with the transformation process. In practice, organizations frequently use implementation-oriented indicators, such as the number of equipment units deployed, the number of processes digitalized, or the number of employees trained. Considered individually, such indicators do not provide sufficient information about the value generated by transformation. From this perspective, a mature performance management system should link implementation indicators to economic, environmental, and social outcomes. This approach allows management to distinguish between the level of activity undertaken and the actual impact generated within the organization.

The economic dimension of performance may be assessed through indicators such as productivity, unit cost, Overall Equipment Effectiveness (OEE), defect rates, downtime, and service quality. The environmental dimension may include energy intensity, water consumption, emission levels, material losses, waste generated, and the waste recycling rate. The social dimension may focus on occupational safety, the development of competencies, employee engagement, and internal mobility. Such an indicator framework is consistent with the Industry 5.0 perspective, in which organizational performance is no longer reduced to technical efficiency alone, but is assessed through a balance between competitiveness, sustainability, and human-centricity. Within this framework, the performance measurement system becomes a mechanism of managerial integration, as it enables the simultaneous evaluation of objectives that have traditionally been considered separately.

The relationship between digitalization and the circular economy represents one of the relevant applications of this integrated framework. Internet of Things technologies can provide real-time information on the use, condition, and performance of assets, while advanced data analytics can help anticipate equipment degradation and optimize maintenance interventions. Ching et al. (2022) show that Industry 4.0 applications can support multiple functions of sustainable manufacturing and that the relationships among these functions are interdependent. From this perspective, digitalization should not be viewed exclusively as a means of improving efficiency; it can also provide the informational and operational infrastructure required for the transition toward circular production models. However, this contribution can be fully realized only when circularity objectives are explicitly integrated into the design of technological architectures and decision-making processes.

This perspective is also supported by the literature on industrial policy and sustainable industrialization. UNIDO (2024) highlights the role of digitalization, innovation, and decarbonization in shaping contemporary industrial policies and emphasizes the importance of capabilities, access to finance, and institutional consensus in implementing change. For organizational management, the main implication is that transformation processes do not take place in an institutional vacuum. Regulations, available infrastructure, labor market conditions, access to skills, public policies, financing mechanisms, and innovation ecosystems can directly influence the pace, cost, and feasibility of transformation.

4. CONCLUSIONS

Sustainable industrial transformation cannot be reduced to the adoption of new technologies or the digitalization of isolated processes. The introduction of artificial intelligence, automation, IoT solutions, or other Industry 4.0 technologies can generate sustainable results only when accompanied by coherent changes in strategy, processes, competencies, organizational structures, and governance mechanisms. From this perspective, change management represents a central component of industrial transformation because it creates the link between technological investment and the actual outcomes achieved by the organization.

Organizational readiness for change must be assessed from several perspectives. Technological infrastructure and data quality are important, but they are not sufficient. Employee competencies, organizational culture, management involvement, cross-functional collaboration, and the organization's capacity to learn directly influence transformation outcomes. Consequently, an organization's level of maturity should be assessed before major investments are undertaken in order to identify both opportunities and potential gaps that may constrain implementation.

The proposed managerial framework integrates six components: diagnosing the need for change and the level of organizational readiness, strategic alignment, leadership and employee mobilization, the development of competencies, experimentation and scaling, and the institutionalization of change combined with continuous learning. These components should not be viewed as a rigid sequence, but rather as an iterative process. Organizations need to be able to revisit initial decisions, adapt projects in response to the results obtained, and continuously develop their competencies and implementation capacity.

An important implication is the need to integrate competitiveness objectives with sustainability goals. Technological, economic, and environmental projects should not be developed in isolation, as their effects are interdependent. An investment in digitalization may simultaneously contribute to higher productivity, lower resource consumption, improved working conditions, and greater organizational resilience. At the same time, trade-offs may arise between these objectives, and management has the responsibility to identify and incorporate them into the decision-making process.

In this context, the performance measurement system plays an essential role. The number of digitalized processes, connected equipment, or trained employees may indicate implementation progress, but does not demonstrate the existence of a meaningful impact. The evaluation of transformation should therefore include economic, environmental, and social outcomes. This approach is consistent with the Industry 5.0 perspective, which broadens traditional performance criteria and places greater emphasis on sustainability and the human dimension.

Digitalization can also support the development of more circular production models. Asset monitoring, data analytics, and digital traceability can contribute to a more efficient use of resources and create favorable conditions for reuse, remanufacturing, and recycling. However, these benefits do not emerge automatically from the introduction of technology alone. They depend on the extent to which circularity objectives are integrated into process design and managerial decision-making.

Another conclusion concerns the role of organizational capabilities. Competitive advantage does not derive exclusively from access to a particular technology, as similar technologies may generate very different outcomes across organizations. The difference lies in the organization's ability to identify relevant opportunities, mobilize the necessary resources, and reconfigure processes and competencies as conditions change. Industrial transformation should therefore also be understood as a process through which organizations strengthen their capacity to adapt.

The findings also suggest the need for a broader perspective on the success of transformation projects. Meeting deadlines, staying within budget, and complying with technical specifications remain relevant, but they are not sufficient. Success should also be assessed in terms of the effective use of new systems, the achievement of expected benefits, the development of competencies, the integration of new practices into routine activities, and the organization's capacity to adapt them over time.

From this perspective, sustainable industrial transformation can be understood as a continuous process of reconfiguring technologies, processes, competencies, and management mechanisms with the aim of creating economic, social, and environmental value. Change management provides the mechanisms through which these dimensions can be coordinated and embedded into stable organizational practices without reducing the organization's capacity for further adaptation.

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